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ON THE
FRUCTIFICATION
OF THE
SUBMERSED ALGÆ.

BY
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FROM THE
PHILOSOPHICAL TRANSACTIONS.

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ON THE FRUCTIFICATION, &c.

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THE light which the prevailing spirit of inquiry and observation has thrown on the means of reproduction allowed by nature to vegetable beings, is not yet equally diffused over all of them. Those whose simpler organization seems, when examined, to want some of the parts which we are accustomed to consider as essential to generation, continue to the present moment more or less involved in darkness ; and their fecundation, and means of reproduction, are still objects of doubt and inquiry. Amongst them the Fuci, Ceramiums, Ulvæ, Confervæ, all submersed algæ, are perhaps in the number of the less illustrated. It is probable that their peculiar way of living, which requires from nature a particular modification in the parts destined to reproduce them, as well as in the means of performing this operation, has been the principal cause of the perplexity of naturalists on this subject. They have either sought for things in their ordinary form, which nature furnishes to these plants under a different one, adapted to their circumstances ; or they have thought that she deviates from her usual ways, when she only makes use of her stubborn versatility, enforcing the execution of her general plan, by the means which at first sight seem to make her deviate from it. In the present memoir I shall

endeavour to ascertain what parts of these plants perform the sexual functions: and, in order to be clear, I will first relate in a few words, what has been observed and believed on this point, and proceed afterwards to the exposition of the opinions which observation and the strictest analogy induce me to hold on this subject.

REAUMUR was the first naturalist who bestowed a proper attention upon the fructification of the Fuci. Two elaborate memoirs of this great man are to be found, in the Parisian Transactions for the years 1711 and 1712, in which he endeavours to persuade us, that the vesiculæ filled with small grains are the female part of the fructification, in the fuci, and the filamentous hairs, which are found in different parts of the frons, the male organs. He examined eleven species of fuci, in eight of which he found grains, and only in six the filamentous hairs. It is unlucky for his opinion, that these hairs have no antheræ, and still more unlucky, that their existence has no relation at all to that of the vesicles which bear the grains, for they are persistent through all the life of the plant, without any remarkable alteration. Their situation besides is very unfit for the fecundation of the grains, except in the *Fucus elongatus*. Notwithstanding the weight of these objections, which he did not conceal, this otherwise sensible naturalist tried to the last to support by hypotheses, what he could not fairly prove by observations. His great name, joined to the general ascendancy which the sexual system gained a little after all over Europe, gave nevertheless a common currency to his opinion; and it was received, though in a wavering manner, by LINNÆUS himself, and, what is more surprising, by the last of the JUSSIEUS. These great men indeed gave it as the prevail-

ing opinion of the day, not confirmed by any sanction of theirs. This was not the case of less profound botanists; for they, as the fashion then was, attempted to see stamina and antheræ, like the common ones, wherever they had not been observed before. I deem it unnecessary to stop a moment to consider the multitude of supposed stamina, which DONATI, GRISELINI, and others, imagined they had found in Fuci, and Ulvæ, because it is at present clearly evinced that these fancied stamina are only organs of nutrition.

Cooler observation and reflection exploded at length all these dreams; but GMELIN, and GÆRTNER, the two greater among the naturalists who followed a different way of thinking, went perhaps too far on the opposite side.

GMELIN, convinced both by reason and observation of the inutility of the REAUMURIAN antheræ, and writing at a time when the recent publications on the hydræ, and on the aphides, had made it fashionable to find examples of multiplication of organized bodies without fecundation, determined to consider these plants as in the same predicament. Every one may see, in his *Historia Fucorum*, the elaborate discussion by which he endeavours to establish his opinion. It dazzles at first sight, but, on a candid examination, all his arguments, when deprived of the apparatus of science which accompanies them, may be reduced to the following; namely, that since the supposed male organs are not such in reality, and no others are to be found, the small grains which act as seeds are prolific, without receiving external fecundation. We shall see as we proceed, how groundless is the supposition on which this argument rests.

GÆRTNER, by far a deeper naturalist than the preceding, and keeping more closely to the ways of nature, would, no doubt, have given us the true and simple account of the fruc-

tification of the submersed algæ, if the specious ADANSONIAN theory of aphrodite plants, and his own ideas of the perfect seed, had not led him (according to my opinion) astray. The grains of the Ceramiums and Ulvæ, and the lateral internodia of the Confervæ, he excludes from the number of seeds, and believes them to be gems of a particular kind, which he calls *gongyli*, or *gemmae carpomorphæ*, consequently not standing in need of fecundation. The grains of the fuci he judges to be true seeds; but, in this case, he believes that the uterus performs the male functions, and that the plants, in respect to their fecundation, are *aphroditæ*, having only the *apparatus fœmineus, et intimam utriusque sexus sub specie singuli copulam*. Both he and GMELIN, forced by phænomena which they could not help observing, have been in some moments very near to what I conceive to be the truth, but have sacrificed it to preconceived opinions.

In the last year two English botanists, to whom science stands indebted for many excellent descriptions and figures of fuci, Major VELLE, and Mr. STACKHOUSE, treated this same matter, the first at large, the second occasionally. Both have stated, with great ingenuity and candour, the many objections which attend the existing systems, and both declared themselves not fully satisfied with the present state of our knowledge on this subject. Mr. STACKHOUSE, indeed, seems to cherish hopes of future discoveries of the male organs, in what he calls the concealed fibrous fructification, the antheræ not seeming necessary to him, nor the farinaceous pollen.* Perfectly agreeing with him, in what respects the needlessness of a farinaceous pollen, I cannot accede to the other parts of his opinion. A membranaceous loculament, containing the

* *Nereis Britannica*, in the preface, and page 30.

pollen, is the only necessary part of the male apparatus in plants; the filaments and the fibrous texture are only the pedicles of it, and very far from being necessary, as the sessile antheræ of numberless fructifications clearly prove. If a fibrous concealed structure could be esteemed of any use, it was already found by GMELIN, in the seed-vessels of the true fuci,* and elegantly described by Major VELLE, in the *Fucus Vesiculosus*, and by Mr. STACKHOUSE himself, in the *Fucus Siliquosus*; but, even when magnified, it offers nothing more than simple tubular vessels, with frequent anastomoses, very remote indeed from the nature of a male apparatus.

Having stated the leading systems on the fructification of submersed algæ, I will next submit to this Society such opinions as the phænomena I have observed induce me to have about it.

All these plants are furnished with grains, which are a temporary production, and, by their falling, give rise to new individuals of the same species. In the true fuci, they are contained in an uterus, which has a temporary existence, and for their sake only, where they have a placentation, and are covered by a testa, or coat of their own. Nobody doubts that they are true seeds. The *Ceramiums* and *Ulvæ* have the same grains, as means of reproduction; and the *confervæ* also have them, though of a different shape. What then can be the reasons why these last are to be considered as *gongyli* and *gemmae carpomorphæ*?

The only arguments adduced to deprive them of the nature of seeds are the three following.

1st. The grains of the *Ulvæ* and *Ceramiums* are solitary, not

* *Hist. Fucorum*, pag. 25, et seq.

contained in a proper uterus, consequently without a placentation. They are, says GÆRTNER, part of the medulla of their mother, and their skin is part of the maternal one.*

2d. They do not, in germinating, leave any coat behind.†

3d. In the *confervæ*, whose grains have some likeness to fresh internodia, two or more of them very often coalesce, but give rise to only one individual.‡

All these reasons require to be candidly discussed; and I hope the result of the investigation will afford us many additional motives to believe them to be true seeds.

The first of these objections cannot stand the test of close examination. The grains of the *Ceramiums* (like those of the true *Fuci*) fall at a proper period, which GÆRTNER calls *senium*, but which others will call maturity. If gently squeezed, they come forth from the little cavity where they are formed, and which they must leave when ripe. They come forth whole, and disengaged from the mother, and from every part of the frons; they have therefore a skin of their own. They are contained in a small uterus, proportionate to their size, which is of a temporary existence, and for them alone; where they are no doubt affixed by some placentation, from which, when they come to maturity, they are disengaged and fall. If we add to these considerations, that of their existing there enveloped in a soft juicy substance, all their difference from the seeds of the true *fuci* wholly disappears; § and a strong probability arises, that GÆRTNER'S

* *De Fructibus*, &c. pag. xvi. et seq.

† Ibidem, pag. xi.

‡ Ibidem, pag. xviii.

§ I have made mention of the *Ceramiums* in this paper only to follow GÆRTNER through his objections. This genus, first made by DONATI, adopted by ADANSON, and GÆRTNER, has in reality scarcely any difference from the *fuci*.

observations were made on dry specimens, as well as with a mind not wholly impartial to his preconceived theories.

The second reason is of a more specious nature, and requires serious attention. Animals are divided into oviparous and viviparous, and a generally received comparison points out the seeds as the eggs in plants, and the gems as correspondent to living born foetuses. We cannot conceive, says GÆRTNER, an egg where the animal, when coming forth, does not leave the shell behind; and, in the same manner, we cannot conceive a seed where the coats are not left behind in the germination. The grains of the *Ulvæ*, *Ceramiums*, &c. according to him, do not leave any coat when they germinate, and are consequently *gemmae carpomorphæ*. Every candid naturalist will easily acknowledge, that we are not possessed of observations sufficiently decisive to enable us to speak dogmatically, on phænomena so little obvious as the germination of these grains. But I will not contest the fact, I will only examine the principle.

This general rule, of judging whether these grains be seeds or gems, by their leaving their coats in the germination, or not, is contradicted by nature, both in the instance of gems, and in that of eggs. All gems, properly so called, throw off their scaly hybernacula in the act of germinating. On the contrary, the eggs of frogs and toads leave no coat at all in their hatching, because they are possessed of none. Their very viscous albumen answers, in such an element as water, all the purposes the testa accomplishes in other eggs. Allowing GÆRTNER the exactness of his observation concerning our plants, the analogy between these submersed algæ and the aquatic oviparous quadrupeds would be striking, since both

those plants and these animals are capable, from their structure, of being nourished by absorption; their embryos are hatched in the same element, and equally surrounded by a tenacious mucous substance, without any exterior coats. If the spawn of frogs be eggs, the grains of these plants must be seeds.

The third objection, very far from being an urgent one, is, I am persuaded, a capital reason to believe that the seeming lateral internodia of the *Confervæ*, since they are capable of cohering two or more together, and produce only one individual, are true seeds, and not gems. The coherence of two living embryos, whether gems or seeds, may form monsters, but it is equally impossible, in both cases, that perfect individuals should regularly be formed by such coalition. Observation daily shows, that of two or more neighbouring gems or seeds, one may thrive by rendering the other abortive; but, in this case, gems never cohere, the abortive one falls. In seeds, on the contrary, not only the abortive coheres to the thriving one; but this abortion happens oftener in the several species of plants, in proportion as the seeds, by their situation, are apt to cohere. In some genera it is even a regular proceeding of nature, as in the *Dalea*, *Lagoëcia*, *Hasselquistia*, *Sapindus*, *Ornitrophe*, &c.

These objections having been I hope satisfactorily answered, I do not hesitate to consider these grains of the submersed algæ to be, what obviously they seem, their effective seeds. The figure, formation, and temporary fall of these bodies, would never have left any room for the above doubts, if their fecundation had been easily accounted for. This point we must now proceed to investigate, and examine whether the mucous

substance which surrounds these seeds can be considered as true pollen.

Pollen is by its nature immiscible with water, and specifically lighter than that fluid. In the aquatic plants, which have a farinaceous pollen, the buds of the flowers emerge from the surface of the water, and the fecundation is performed in the open air. The phænomena attending the blossom of the *Potamogetones*, *Myriophylla*, *Vallisneria*, &c. are too well known to require a particular mention. In some aquatic plants, whose flowers have not the faculty of emerging from water in the period of fructification, but still are endowed with farinaceous pollen, nature has taken every precaution to defend it from that element. The flower of the *Zostera* is situated, and its fecundation happens, in the interior cavity of the stem, which opens itself afterwards to let loose the fecundated seeds. The concave bases of the leaves in the *Isoetes*, closely adhering to each other, and perhaps more so in the act of fecundation, forbid the entrance of water to the minute flowers situated within them. In the *Pilularia*, and *Marsilea*, whose flowers are exposed to inundations, the fecundation is performed in perfectly closed vessels. Even in plants living in the air, nature employs numberless well known contrivances, to shelter the farinaceous pollen from the contact of water in rainy seasons.

The pollen, to be active in fecundation, needs not always be farinaceous. In most *Apocynæ* it is rather a fluid; in the *Orchideæ* it is an aggregate of solid parts, of a ceraceous appearance; in some *Contortæ* it is found in a solid or rather viscous state. In the *Pilularia*, and *Marsilea*, the particles of the pollen are kept in small bags of a mucous substance, compared by BERNARD DE JUSSIEU to dissolved

gum. The original state in which it is found in every flower, before the act of fecundation, is that of a mucus, but it is perfectly active even in that state, since its particles, after becoming a little dry, if put into certain fluids, are seen, by the help of the microscope, acting in the same manner as when in the state of perfect farina.

The plants whose fructification lies unsheltered under water are very few in number; and such of them as have been hitherto thoroughly examined, (the *Ceratophyllum* and the *Chara*), have antheræ furnished with mucous pollen, not bursting in the fecundation. From the time of DILLENIIUS it has been observed, that the submersed antheræ of the *Ceratophyllum* never burst, but are found whole, though the seeds be ripe.* If squeezed, they shed a soft and pulposus matter, like that which is found in unripe antheræ. DILLENIIUS suspected that the fructification of the *Chara* being equally submersed, its antheræ and pollen would be of the same nature with the preceding, and observations have fully confirmed the conjectures of this great naturalist. The antheræ of the *Chara* do not burst in fecundation; its pollen is mucous; the germen has no pistillum, and is probably fecundated through its receptaculum, as there exists in each internodium, according to modern observations,† a chain of vessels which twist round the antheræ and the fruit, and in which a circulation of humours is visible, at least in the period of fructification.

If pollen therefore, under the shape of farina, be unfit for fecundation in the water; if nature has taken a particular care to guard this operation from the presence of that element; if pollen can exist in an active state under a mucous appearance;

* *Plantæ Gissenses*, pag. 91.

† CORTI, *Osserv. Microscop.* Lucca, 1774.

and if the antheræ of perfectly submersed flowers are nothing else than closed vessels filled with mucous pollen; what doubt can we entertain, that the mucilaginous vesicles of the submersed Algæ (which contain also their seeds) are antheræ, and very appropriate to the nature and situation of these plants?

An observation made by GLEICHEN shews more clearly the propriety of such a fructification. The pollen of any flower, when put into water, in a very short time begins to move, and its particles agitate themselves in every direction, perfectly resembling the most lively animalcula. Their activity in this state lasts some time; but, if the least quantity of salt be put into the liquor, death quickly ensues, from which they never more recover.* This inclosed mucilaginous fructification was therefore the only one which could ensure existence to vegetables living chiefly in sea-water, with which their mucus is found to be immiscible.†

A still more urgent consideration will, I hope, determine those who may hesitate to consider the mucus of these plants as pollen, and the vesicles which contain it as antheræ. The parts of fructification, in all plants, are temporary, and their existence is relative to their particular functions, and to each other. The moment the fecundation happens is a moment of crisis: henceforth the fecundated parts proceed to grow and perfect themselves, the fecundating ones change and decay. This is a general law of nature, to which we know no exception, nor can any be easily conceived to exist. We must remark, that there is an epoch when the mucous substance in the vesicles of the fuci suffers a material alteration, but the

* GLEICHEN *Observ. Microscop.* pag. 32.

† GMELIN *Hist. Fucorum*, pag. 27.

grains proceed to their perfection. In the *Fucus vesiculosus* this change of colour and consistency in the mucus is evident to common sight. It is still more evident in the *Fucus selaginoides*, where the temporary bright and vivid colour of the mucus, followed by a prompt decay after that period, has struck even those naturalists who most decidedly opposed the existence of male parts in these plants;* and I am confident, from the steadiness with which nature adheres to her general plans, that proper observations will demonstrate the same in every species of these submersed algæ, and confirm what the fore-mentioned analogies induce me to think, viz.

That the vesicles of all these plants, whatever be their shape, if containing grains and mucus, are to be considered as hermaphrodite flowers; the grains they contain as their seeds, and the mucous substance as their pollen.

* GÆRTNER, pag. xxxii.